

WASHINGTON, D. C. 20024

FROM: N. W. Schroeder

(CATEGORY)

SUBJECT: Effects of Deletion of LM Erectable
Antenna on LM-MSFN Communications
Case 320

DATE: September 30, 1970

FROM: N. W. Schroeder

MEMORANDUM FOR FILE

INTRODUCTION

Expected communications performance of the LM and LCRU downlinks have been calculated to determine the impact of the proposed deletion of the LM erectable antenna on Apollo J series missions (see Attachment 1). The results of these performance calculations are tabulated in Tables I and II.

The LM/MSFN system parameters used in these calculations were taken from Apollo 12 mission data (Reference 1). Calculated power levels appearing in Tables I and II are taken from Reference 2. The LCRU/MSFN system parameters are taken from the RCA preliminary design report (Reference 3).

RESULTS

Results of margin calculations in Table I indicate that Apollo mission data can be transmitted from the lunar surface without the use of the LM erectable antenna. The deletion of this antenna, however, does place the following constraints on data transmissions from the lunar surface:

1. An Earth station using a 210 foot diameter antenna is required to achieve positive margins for the extra-vehicular astronaut data transmitted in the frequency modulated (FM) mode from the LM steerable antenna.
2. Low power transmissions from the LM steerable antenna to an Earth station using an 85 foot diameter antenna are limited to voice and low bit rate telemetry data in the phase modulated modes. The voice in this case will be marginal, but should be useable.
3. An Earth station with a 210 foot diameter antenna is required to achieve positive margins for reception of the color television signals transmitted from the LM steerable antenna.

Results of margin calculations, in Table II, indicate satisfactory reception of the Lunar Communication Relay Unit (LCRU)

voice and television data, at a ground station using an 85 foot diameter antenna. It should be noted that in Table II the LCRU color television margin is calculated on the basis of a threshold S/N of 8 dB or a resulting total received signal power of -130.2 dBW; however, the threshold specified for Apollo 12 and given in Table I is a total received signal power of -124. dBW. This approximate 6 db improvement in threshold level for the LCRU television channel corresponds to the performance improvement expected from the use of pre-emphasis in the LCRU television equipment.

CONCLUSIONS

The results of the margin calculations given in Tables I and II are in agreement with the performance predictions of MSC, Attachment 1, except as follows:

1. Voice transmitted from the LM steerable antenna in the phase modulated mode at low power (Power Amplifier (PA) off) to a ground station using an 85 foot antenna will be marginal but useable. As stated in the table of Attachment 1, the margins calculated for the high bit rate telemetry data, if transmitted simultaneously with voice, (-9.2dB) are very negative for this configuration. By quieting the voice channel and using the required signal to noise (S/N) threshold for a bit error rate of 10^{-4} rather than 10^{-6} the telemetry channel margin is improved, but is still negative by 4.7 dB. Therefore the high bit rate telemetry data is not expected to be useable in this link configuration.
2. High bit rate telemetry data transmitted over the LM steerable antenna in the phase modulated mode at low power to a ground station using a 210 foot diameter antenna will have a bit error of about 10^{-4} .
3. An Earth station using a 210 foot diameter antenna is required to achieve positive margins for the signals transmitted in the frequency modulation mode from the LM steerable antenna.

N. W. Schroeder

N. W. Schroeder

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Attachments 1 & 2
Tables I & II

TABLE I
COMMUNICATIONS CAPABILITIES FROM THE LM
STEERABLE AND ERECTABLE ANTENNAS

ANTENNA/GROUND STATION	PA	VOICE				TELEMETRY				TELEVISION			
		FM	PM			FM (BER = 10 ⁻⁴)		PM (BER = 10 ⁻⁶)		B & W	COLOR		
		EVCS DUAL EVA	FULL MODE† HBR	WITH TELEMETRY		HBR	LBR	FULL MODE† HBR	WITH VOICE				
				HBR	LBR***				HBR††	LBR***			
	dBW*	-126.6	-140.6	-141.5	-146.2	-131.6	-140.2	-138.8	-139.7	-149.2	-132.5	-124.0	
LM STEERABLE/85'	dBW**	-148.9	-22.3	-8.3	-7.4	-2.7	-17.3	-8.7	-10.1	-9.2	+	-16.4	-24.9
LM STEERABLE/85'		-131.6	-5.0	+	+	+	0	+	+	+	+	+	-7.6
LM STEERABLE/210'		-140.9	-14.3	+	+	+	-9.3	-.7	-2.1	-1.2	+	-8.4	-16.9
LM STEERABLE/210'		-123.6	+	+	+	+	+	+	+	+	+	+	+
LM ERECTABLE/85'		-140.6	-14.0	+	+	+	-9.0	-.4	-1.8	-0.9	+	-8.1	-16.6
LM ERECTABLE/85'		-123.3	+	+	+	+	+	+	+	+	+	+	+
LM ERECTABLE/210'		-132.6	-6.0	+	+	+	-1.0	+	+	+	+	-.1	-8.6
LM ERECTABLE/210'		-115.3	+	+	+	+	+	+	+	+	+	+	+

* TOTAL RECEIVED SIGNAL POWER REQUIRED FOR SATISFACTORY OPERATION OF CHANNEL

** TOTAL RECEIVED SIGNAL POWER

*** MODE 7 CONFIGURATION (MODULATION INDEXES: $m_{\text{voice}} = 1.3$, $m_{\text{tlim}} = .7$)

†† MODE 2 CONFIGURATION (MODULATION INDEXES: $m_{\text{voice}} = .7$, $m_{\text{tlim}} = 1.3$)

+ COMMUNICATIONS MARGINS ARE POSITIVE

† FULL PM MODE IS DEFINED AS THE SIMULTANEOUS TRANSMISSION OF VOICE, TELEMETRY, AND RANGING

THE SYSTEM PARAMETERS USED TO OBTAIN THE ABOVE PERFORMANCE PREDICTIONS ARE CONTAINED IN REFERENCE 1 (APOLLO 12 DATA)

TABLE II
COMMUNICATIONS CAPABILITIES
FROM THE LCRU

ANTENNA/GROUND STATION dBW*	VOICE		TELEVISION
	BASE BAND 3 KHZ BAND WIDTH -146.2	SUBCARRIER 48 KHZ BAND WIDTH -146.8	
LCRU (LOW GAIN ANTENNA)/85' - 146.6	-4	+	-16.4
LCRU (HIGH GAIN ANTENNA)/85' - 128.9	+	+	+
LCRU (LOW GAIN ANTENNA)/210' - 138.6	+	+	- 8.4
LCRU (HIGH GAIN ANTENNA)/210' - 121.4	+	+	+

- + COMMUNICATIONS MARGINS ARE POSITIVE
- * TOTAL RECEIVED SIGNAL POWER REQUIRED FOR SATISFACTORY OPERATION OF CHANNEL
- ** TOTAL RECEIVED SIGNAL POWER
- *** THRESHOLD IS BASED ON A REQUIRED CARRIER/NOISE EQUAL TO 8 dB

THE SYSTEM PARAMETERS USED TO OBTAIN THE ABOVE PERFORMANCE PREDICTIONS ARE CONTAINED IN REFERENCE 3. THE ABOVE MARGINS INCLUDE A 3 dB ANTENNA POINTING LOSS.

Attachment 1

Level I

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS 77058

REPLY TO
ATTN OF: PD9/L91-70

JUL 29 1970

TO : NASA Headquarters
Attention: Dr. R. A. Fekken, MA

FROM : Manager, Apollo Spacecraft Program

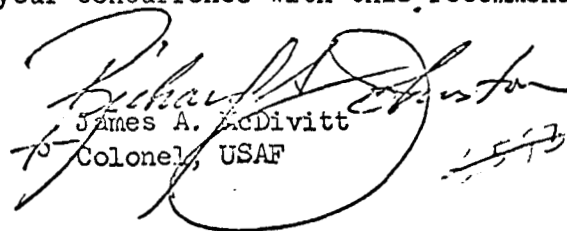
SUBJECT: Deletion of LM S-band erectable antenna

After evaluation of communications systems performance on Apollo 11, 12, and 13, MSC has concluded that the LM S-band erectable antenna is not required to meet mission requirements on Apollo 16-19. As shown on the attached chart, lunar surface LM communications requirements are adequately met when utilizing the LM S-band steerable antenna for transmission to 85' ground stations. Additionally, voice, EMU data and TV requirements can be met utilizing the LCRU in conjunction with an 85' ground station.

By deletion of the erectable antenna from LM-10 and subs, a weight saving of 18.5 pounds can be realized. In addition, approximately 20 minutes of EVA time need not be utilized for erectable antenna set up. A cost saving is expected and no schedule impact will be incurred because of this change.

Additional justification for the deletion of the LM erectable antenna is that use of the erectable antenna stowage area for the LCRU ancillary components can allow greater preassembly of these LCRU components, thus allowing lunar surface time savings approximately 5½ minutes over the present design approach.

→ This office recommends the deletion of the LM S-band erectable antenna on Apollo 16-19, and requests your concurrence with this recommendation.


James A. McDivitt
Colonel, USAF

Enclosure

cc:
MA/W. Stoney
MAT/J. Allman

7/31
#1

COMMUNICATIONS CAPABILITIES

Attachment 2

<u>ANTENNA/GROUND STATION</u>	<u>PA</u>	<u>VOICE</u>	<u>PCM</u>	<u>EMU DATA</u>	<u>TELEVISION</u>
STEERABLE/85-FT	OFF	GOOD (FAIR)**	LBR ** (HBR*)	FAIR (NO)	NO
STEERABLE/85-FT	ON	GOOD	HBR	GOOD **	ACCEPTABLE **
STEERABLE/210-FT	OFF	GOOD	HBR **	GOOD	NO
STEERABLE/210-FT	ON	GOOD	HBR	GOOD	GOOD
ERECTABLE/85-FT	OFF	GOOD	HBR	GOOD	NO
ERECTABLE/85-FT	ON	GOOD	HBR	GOOD	GOOD
ERECTABLE/210-FT	OFF	GOOD	HBR	GOOD	NO
ERECTABLE/210-FT	ON	GOOD	HBR	GOOD	GOOD
LCRU/85-FT	-	GOOD	-	GOOD	FAIR
LCRU/210-FT	-	GOOD	-	GOOD	GOOD

* ALTHOUGH CIRCUIT MARGINS INDICATE HIGH BIT RATE PCM DATA SHOULD NOT BE AVAILABLE, PREVIOUS MISSION EXPERIENCE HAS SHOWN THAT HIGH BIT RATE PCM DATA HAS BEEN OBTAINED IN THIS MODE.

** Note comments in text of memorandum for discrepancies between above stated performance and results of Bellcomm margin calculations.

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BELLCOMM. INC.

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Communications - Case 320

From: N. W. Schroeder

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